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# Farm-to-Factory:
## Automotive Applications of Bio-based Materials in Michigan & Beyond

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# What Are Bio-Based Materials?

# What Are Bio-Based Materials?

## bio-based material

*noun*

1. Products made of substances derived from living organisms (renewable feedstocks) used to replace conventional (petroleum-based, mineral) materials.

2. Could include many common materials (e.g., wood and leather), but typically refers to other materials that have undergone extensive processing.

synonyms: biomaterial, bioplastic, biocomposite, biofoam, natural fibers





Photos from www.autoblog.com

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# What Are Bio-Based Materials?

**Natural Fibers**:

- Flax
- Hemp
- Sissal
- Kenaf
- Wheat straw

**Replace**:

- Fiberglass
- Talc

**Become Fillers and Reinforcements in**:

- Interior door panels & storage bins
- Trim
- Package trays
- Seatbacks
- Engine covers

**Bio-based Polymers**:

- Soybeans
- Corn
- Castor beans
- Sweet potatoes

**Replace**:

- Petroleum-Based Polymers

**Become Foams and Composites**:

- Foam seating
- Headliners
- Seat frames
- Floor mats

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# In the News and on Store Shelves

**Toys**


**Food & Drink Containers**


**Kitchen Products**

**Packaging**

Photos from LEGO, Coke, Heinz, Architec, GreenCell Foam, and Landaal Packaging

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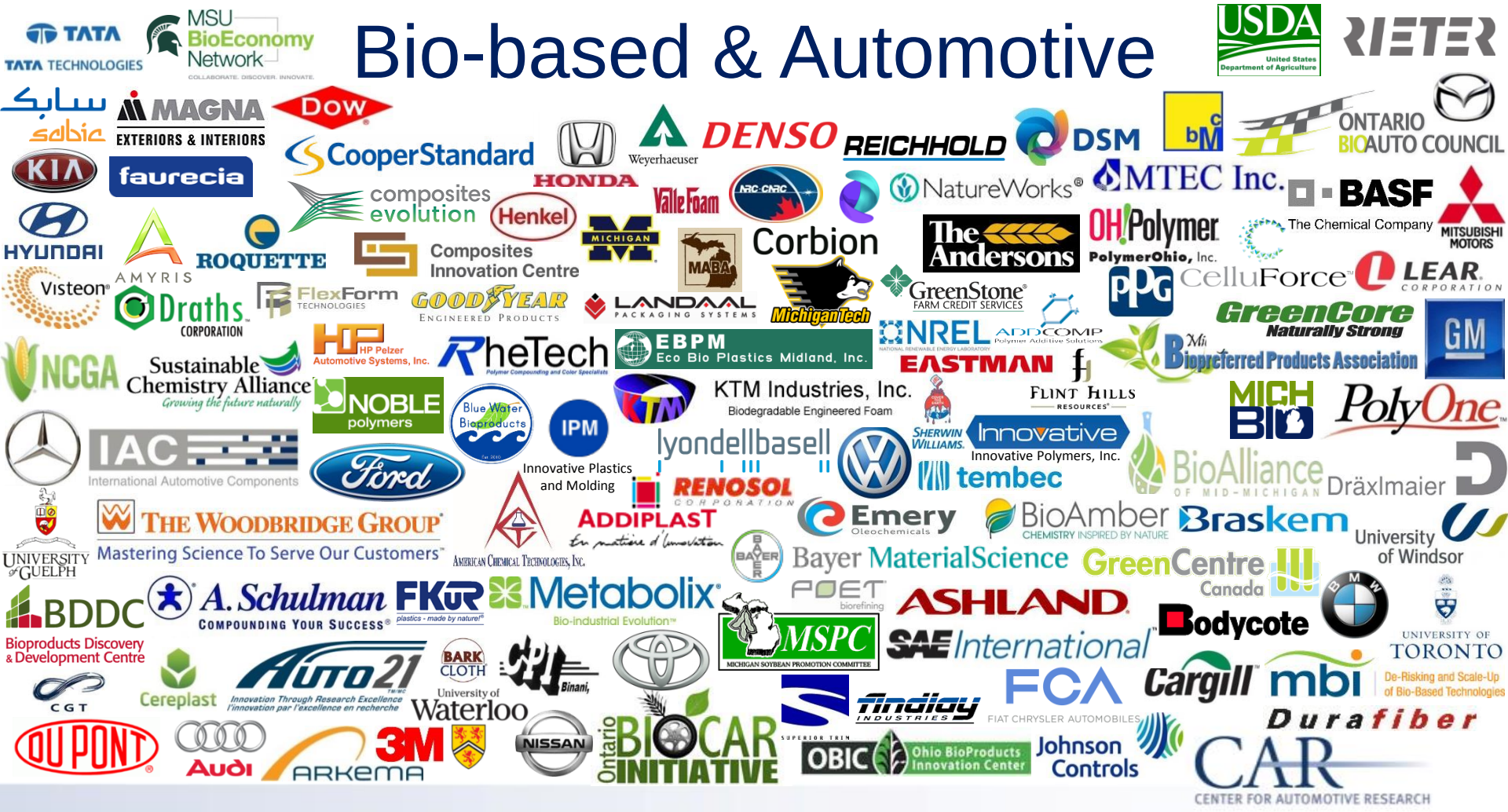
# Bio-based & Automotive



# Bio-based Materials Research at CAR

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# Bio-Based Materials Project Details

- Make it in America Challenge
- Project Partners
  - National Center for Manufacturing Sciences
  - Michigan Manufacturing Technology Center
  - Macomb/St. Clair Workforce Development Board
  - Macomb Community College
- Three year program
  - October 2013 - September 2016


NCMS
NATIONAL CENTER FOR MANUFACTURING SCIENCES

Macomb Community College
Education • Enrichment • Economic Development
Discover. Connect. Advance.

MMTC
A NIST MEP NETWORK AFFILIATE

MICHIGAN WORKS!®

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# Bio-Based Materials Project Goals

- Build employment and facilitate new investment in bio-based materials manufacturing
- Identify and meet with stakeholders involved in the bio-based materials space
- Create a roadmap report describing gaps and opportunities to make products commercialization-ready

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# Automotive Usage

# Bio-based Automotive History

- Early 1900s: Bakelite distributor caps, straw-reinforced Model-T steering wheel
- 1930s: Parts using soybeans, hemp, wood pulp, cotton, flax, and ramie fiber
- 1940s: Soybean car
- 1990s: Bio-based materials gain traction


Ford's 1941 Soybean Car

Photos from www.thehenryford.org

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# Selected Vehicles Made in Michigan

| | Company | Model | Feedstock | Application | Plant |
|---|---|---|---|---|---|
|  | FCA | Dodge Viper | Natural fibers | Door panels, center console | Conner Ave |
|  | FCA | Jeep Grand Cherokee | Natural fibers | Door panels | Jefferson North |
|  | Ford | Ford F-150 | Soy, rice hulls | Foam seating, wire harness bracket | Dearborn Truck |
|  | Ford | Ford Focus | Soy, castor, kenaf, coconut fiber | Foam seating, instrument panel, interior door panel, loadfloor | Michigan |
|  | Ford | Ford Fusion | Soy | Seating headrests | Flat Rock |
|  | Ford | Ford Mustang | Soy | Foam seating | Flat Rock |
|  | GM | Chevrolet Impala | Flax | Trim, rear shelf | Hamtramck |
|  | GM | Chevrolet Volt | Soy | Foam seating | Hamtramck |

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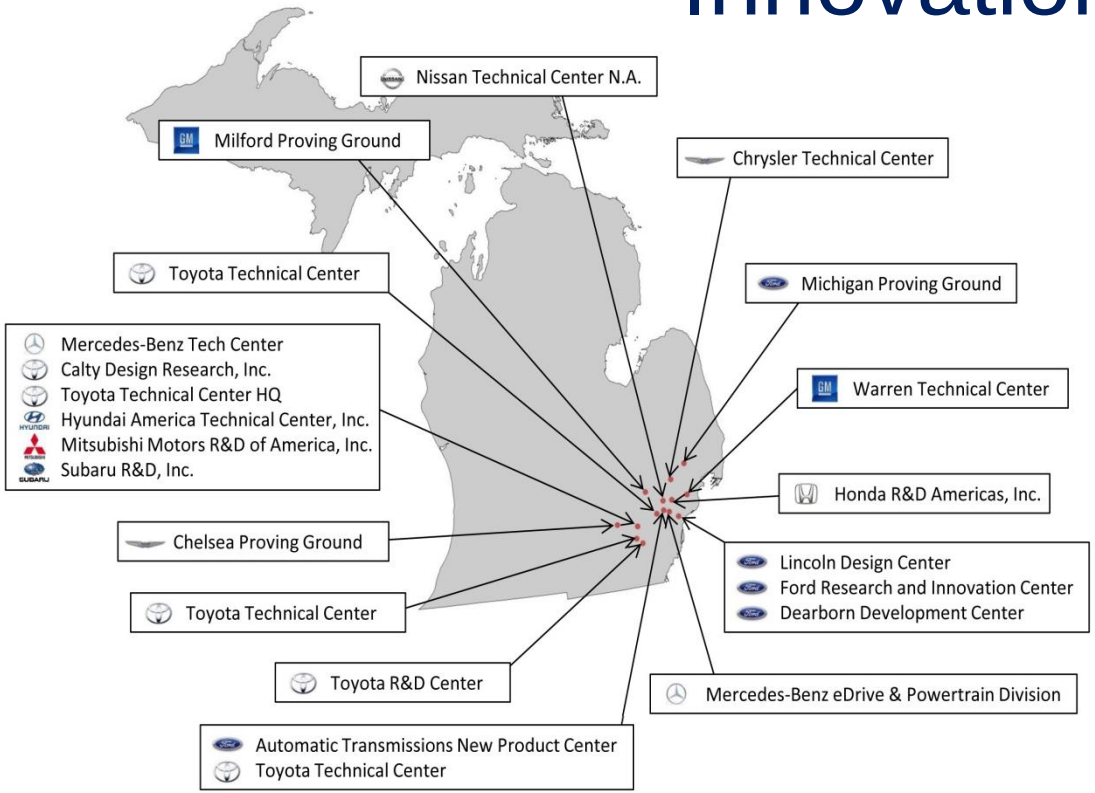
# Why Michigan?

# Michigan as the Hub of Automotive Innovation




- More than 350 automotive research and development (R&D) facilities
- Responsible for ≈75% of U.S. automotive R&D spending

Sources: CAR Research 2015, NSF 2014

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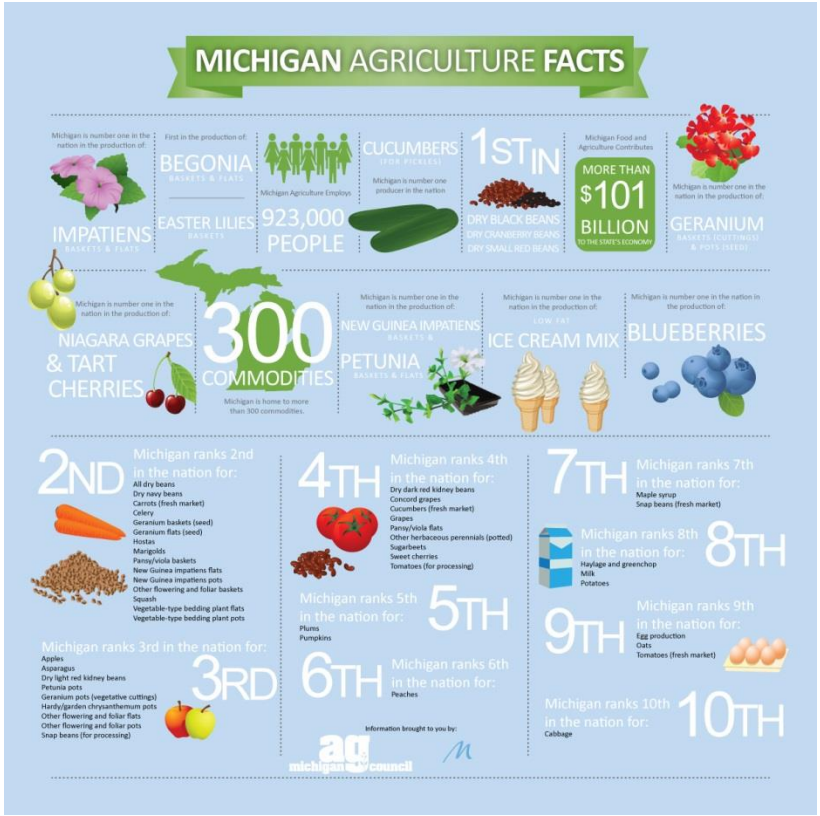
# Michigan Agriculture by the Numbers




- 54,900 farms in Michigan
- 10 million acres of farmland
- >$100 billion in annual economic activity
- >300 commercially produced agricultural commodities
  - Top Producer of 18 commodities
  - Ranks in top 10 for 56 other commodities

Sources: MI Ag Council 2013, MDARD 2012, and MSU Product Center 2014

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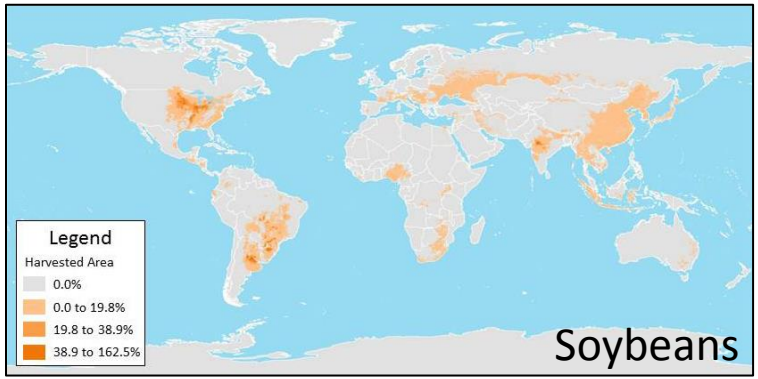
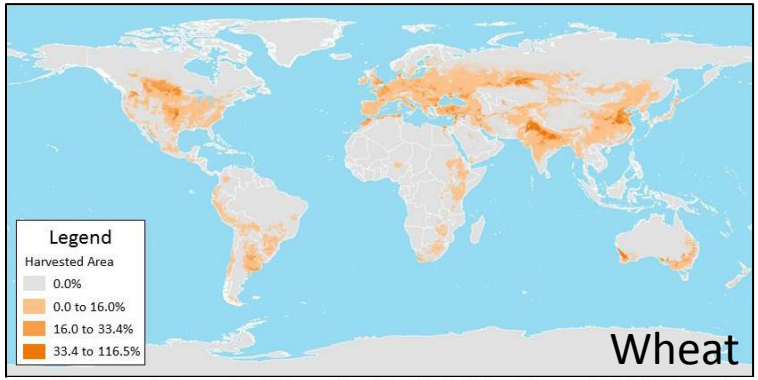
# Feedstock Geography




Note, harvested area is the proportion of the proportion of the grid cell which contains areas planted with the crop; the harvested area may be greater than 100% because of multiple cropping.

## North America

- Soybeans, corn, wheat, cotton, wood
- United States is the largest oil crop producer

## Other Regions

- Castor beans, sugar cane, bast fibers, leaf fibers

## Developing Local Crops

- Testing of fiber crops in North America
- Properties change with geography, climate
- Sustainability aspect related to distance traveled

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# Commercialization

# Case Studies

1. Ford Flex Wheat Straw-Reinforced Storage Bin
2. Toyota Camry Castor-Based Radiator End Tank
3. Ontario BioAuto Council Commercialization Fund




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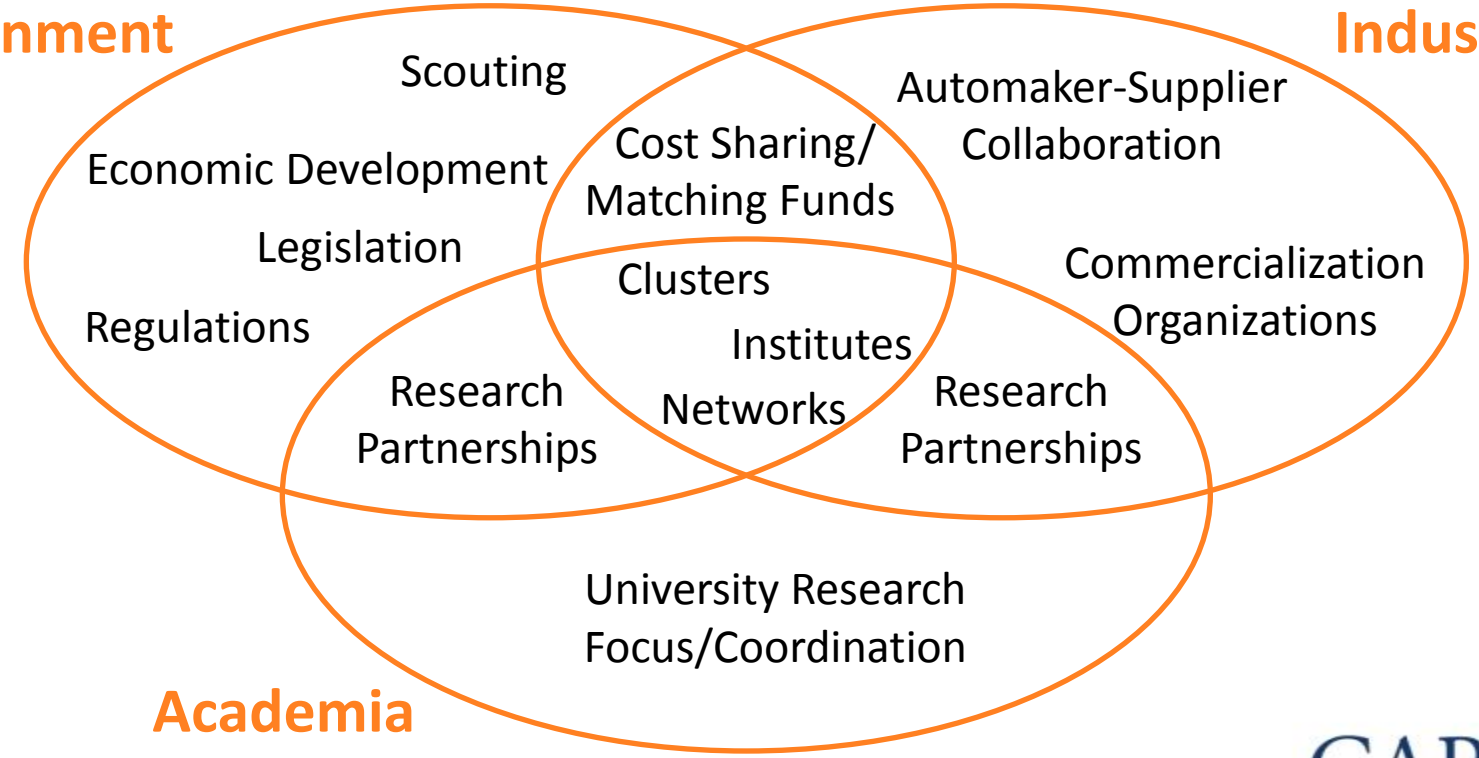
# Commercialization Pathways

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# Existing Efforts and Future Opportunities

Michigan Forest Biomaterials Initiative (MiFBI)



Center for Bioplastics and Biocomposites ($CB^2$)





USDA-led Manufacturing Innovation Institutes


Biomanufacturing

Nanocellulosics

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# Commercialization Challenges

- Changes
  - Material Properties
  - Manufacturing Processes
- Approval Process
  - New Failure Modes
- Cost
  - Scale
  - Feedstock
- Supply Chain
  - Single Source


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# Initial Conclusions

- Bio-based materials are not poised to take over auto industry
  - Low petroleum/natural gas prices
  - Barriers to entry in automotive
- **Yet these materials are not going away…**
  - New  materials
  - New applications

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